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A DEFINITION OF PERCEPTION WITH SPECIAL REFERENCE TO VISUAL ACUITY TESTS*

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Any physical object external to the body that reflects light in a manner indicating partial absorption, i. e., light, shade and color, may become a stimulus for vision. By vision is meant the entire set of processes from stimulation of the retina to perception. Perception is that associative mental function which classifies the results[1] of the visual stimuli into past experience, so that the object perceived in the present becomes recognized as relative to things perceived in the past.

In discriminating between the ideas implied in "seeing" and perception let us proceed as follows: Seeing includes all the processes by which the partially reflected light is refracted by the optical media of the eye (assisted by correcting lenses if there be such) and is thus formed into a more or less imperfect retinal image which is transmitted via neural mechanisms to the cortical centers for vision. Thus perception means only the true response to the complex stimulus of seeing. This response has the form of integration with past experience and the accompanying overt or implicit reaction to the stimulating object.

Thus: an infant can see but does not perceive until there has been sufficient experience to make association (and hence perception) possible; visual illusion is improper perception caused by poor stimulation (defective vision) or by poor integration (hysteria, excitement, etc.); visual hallucination is perception without direct stimulation.

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[1]The word "result" is here used in preference to "response," since visual response implies perception.

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The problem of measuring visual acuity becomes one of measuring seeing through perception. The several methods of procedure may be classified in three groups: those presenting a familiar object in a familiar background; a familiar object in a strange background; a totally unfamiliar object.

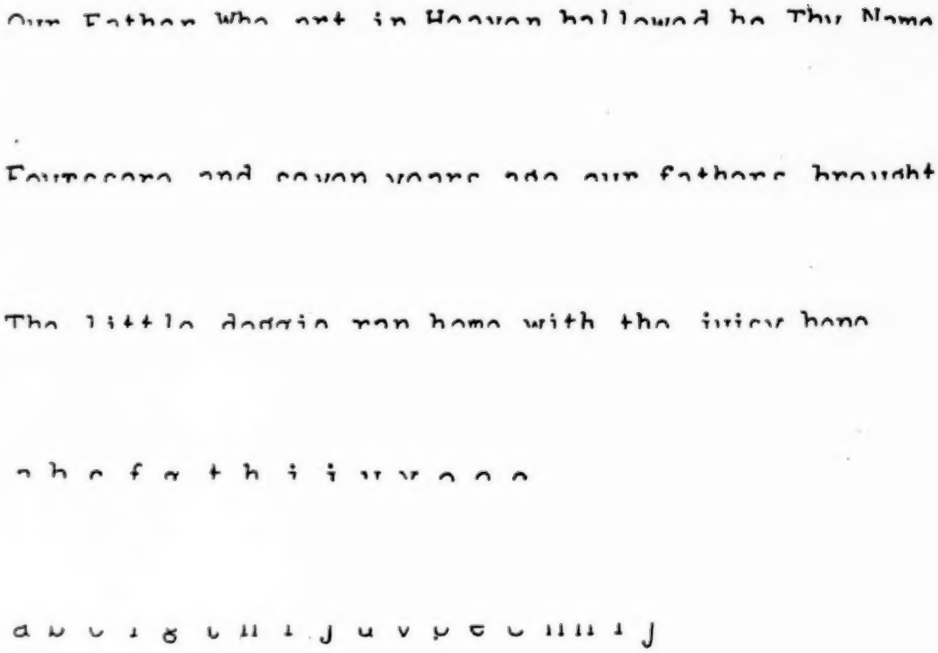
To roughly measure visual acuity we may say, "Can you see that flag on the city hall from here?" This would be an example of the first class of tests. The second is the principle generally employed today. Snellen letters are familiar forms in a strange background and in strange sequence. But the letters are, to literates, quite familiar. Such types as the Ives visual acuity tests, whether employed as a series of lines or of squares, present relatively unfamiliar forms in a strange background.

If we are to measure "seeing" to determine, primarily, whether or not corrective lenses are imperative, the form of test we choose should have no psychological significance. It should simply be commensurate with given physical standards; so wide, so high, so bright, so far away. But all our trouble centers in the fact that we are only able to measure seeing through perception. Hence the form must be interpretable. And a wealth of past experience enters into each individual perception.

We are confronted with the necessity of searching out the basis for visual perception. Is this basis the retinal detail necessary for the perception of each part of the form, or is it a quick and hazy glance? The Gestalt school favors the latter view, that perception depends upon the whole, not upon the parts. In order to demonstrate this, let us remove some of the parts of a form and strive to perceive the whole with these parts lacking.

The first line is familiar to all English speaking Christians, the second is familiar to most Americans. The third is new, but contains several groups or forms that are quite familiar or that are related in a familiar fashion. "The" is perceived as a whole, never as t-h-e. "Little" and "doggie" are both diminutives. Doggies run home, and bones might be juicy. The fourth line is merely a set of letters, some of which can be read easier than others since they have distinguishing marks. The fifth line shows how some letters are perceived from their bottom parts. The last three letters of the fourth line are o, e, c. The last seven letters of the fifth line are o, e, c, h, n, i, j. Although there was no trouble in perceiving the context of the lines of reading, the letters o, e, and c can hardly be discriminated. In the text these letters may not have been perceived at all. This is one of the major criticisms of visual acuity tests using letters. Imperfect retinal images may not interfere with perception at all.

We perceive, then, from relatively meager data, things with which we are FAMILIAR.



So much for the form. What about the background? Are less details necessary for the perception of

the

on this paper than for

h t e

on a test card? Naturally "the" in its own place, before a noun in a sentence, requires little visual acuity. But on the test card, the letters arranged in strange sequence, you may argue that it requires more *attention,* each letter being perceived separately.

The second criterion of a visual acuity test has arisen. The first was familiarity of the form, the second is the attention paid to the form in its background. Let us take examples. In the sentence "the" probably never entered conscious observation, since attention was focused on the context. A Rolls-Royce on Fifth Avenue would scarcely be noticed, but a Rolls-Royce in the slums of Constantinople would surely arouse attention. Here are two instances of the part attention plays in perception. The difference lies in the fact that "the" is *unnecessary* for the sense of the context, being inserted for languge euphony, while the Rolls-Royce is *out of place* in the

Turkish slums. Attention seems to depend principally upon necessity for detailed perception, and upon harmony or congruity.

From our discussion we are now able to suggest a set of criteria for a visual acuity test. The test must present: (1) Slightly familiar form. It must be constructed of lines, curves, shadings, etc., that make sense and yet it must be strange enough to require acute examination of the retinal image in order to use ALL the data available for perception. If perception occurs, that is, if the patient can describe the test for to the examiner, visual acuity may be measured in terms relative to the physical dimensions of the test. (2) Not only must the form require attention, but it must in itself arouse attention. Here we may use our experience with the factors of attention. The form or test may be strange enough to require close study or it may be in a somewhat startling background. Of the two, the strangeness is the easier to manipulate. What is startling to one individual may be dismissed from attention by a lethargic person who expects anything in an optometrists's office anyway. (3) The test must be simple enough to admit of easy discussion and description.

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PERIMETRY FOR THE OPTOMETRIST*

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In approaching the subject of Perimetry the Optometrist is confronted with these questions: Does Perimetry come within the scope of the practice of Optometry? Of what value is it? Does the data obtained by Perimetry justify its inclusion in routine practice?

The subject Perimetry, which includes Campimetry is so vast that an attempt to present anything more than an introduction to the subject in the time allotted to a paper on a program of this kind would be futile. I shall, therefore, confine this paper to an outline of the subject, touching upon the anatomy of the visual pathway, the blood supply of the retina, the physiology of vision, characteristics of defects due to lesions in different parts of the visual nerve path, toxic conditions, vascular disease, functional field changes.

The Optometrist is called upon to determine the cause of eye discomfort. In many case of pathology, the first symptom is eye discomfort and the individual seeks the services of the Optometrist, feeling that a prescription for glasses will relieve the trouble. Many cases may show normal fundi, slight or no refractive error or little muscle imbalance, yet the Perimeter or tangent screen will disclose evidence of disturbance in the functions of the retina, visual pathway or cortical centers which signify pathology. It is in the recognition of incipient pathological changes that we as Optometrists must fulfill our obligation to our consultants. Mapping of the visual fields should therefore be made an important part of our daily practice.

Now it is not to be expected that one who is occupied with an exacting practice can devote much time to research and what I shall present to you is not original but taken from various authors and investigators whose works are available to all.

We will not discuss the merits of the various instruments used in charting the visual fields nor dwell on technique in the use of instruments in this paper, but if time will permit, this can be taken up after the paper is read.

Now what do we mean by the "field of vision?" I am going to quote from Traquair: "The field of vision is that portion of space in which objects are visible at the same moment during steady fixation of the gaze in one direction. With every movement of the eye the field, while remaining practically the same in area, changes

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its contents at its margins so that as the eye is nearly always moving slightly, and as the effects of visual impressions persist for longer than an instant, the extent of the field for practical purposes is somewhat larger than in the case of an actually stationary eye, except in such directions as it is limited by the contours of the orbit. Perimetry, or the measurement of the field, is concerned only with the field of the stationary eye, that is, of the eye when its visual axis is directed as exactly and steadily as possible towards a fixed point. The distinctness with which objects in the field are perceived depends on various physiological factors of which the most important is proximity to the visual axis. The surface of the retina the peripheral receptive organ, receives a minified and inverted image of the field, just as a photographic plate receives an image of a landscape. The fibres of the conducting nerve path are arranged side by side so as to preserve, with certain qualifications, the arrangement of the retina. Thus a transverse section of the path at any level repeats the retina, and, therefore, the field, and the same applies to the receptive center, the visual cortex or cortical retina. The visual nerve mechanism may be compared to a telephone consisting of receiver, wire and station. Faults may be situated at any point and may be of various kinds. The object of perimetry is to ascertain the presence, position and nature of faults in the visual nerve apparatus. Since the field corresponds to a cross-section of the nerve path, a defect in the field will, if properly interpreted, afford some guidance as to the situation and nature of the casual lesion, whether this is in either of the end stations or in the conducting fibres."

Perimetry is a specialized study of one aspect of the symtomatology of vision comparable in many ways to the study of other kinds of disordered sensation. It is a study adapted to clinical purposes, of the reception and conduction of impulses in the visual nerve apparatus and of the results of impairment of this apparatus. 'Its aim is to ascertain and distinguish, within certain limits, various forms of deviation from normal vision and to correlate each alteraton as far as possible with a definite anatomical site of interference and a definite causation, and thus, in harmonious association with other methods, to contribute its quota to the production of a clear and complete clinical picture.

Perimetry has therefore two sides, the technical and the interpretative. For the former the perimetrist requires training and experience in practical methods of examination, and an acquaintance with the chief physical and physiological factors upon which these methods are based; in respect of the latter, his knowledge of the anatomy of the visual nerve path and of the various ways in which different pathological conditions may effect it, cannot be too wide or profound. Further, since the examination is subjective and carried out by question and answer, due recognition must be given to purely

psychical conditions which may influence the patient's responses." The fact that perimetry is subjective, all factors that might distract the patient's attention and ease should be removed. It is best that this work be done in a room set aside for the purpose.

The results obtained depend on the influence of various factors of which the most important is the state of the visual pathways and centers, and the value of the results varies with the ability, experience and discrimination of the examiner in distinguishing and eliminating all disturbing factors.

In some respects the field of vision and the anatomy of the visual nerve path may be regarded as complementary to one another and much of what is known about either is due to the study of the other. Let us now examine the main anatomical features of the visual mechanism.

"The retina may be regarded as consisting of two chief parts, the outer or *photochemical stratum* in which impulses are formed, and the *inner or conducting stratum* which conveys these impulses to the optic nerve. For our present purpose it is unnecessary to attempt to determine any sort of boundary at which the formation and elaboration of impulses cease and are replaced by conduction alone.

The important elements of the outer stratum are the rods and cones and the pigment epithelium. The center of the fovea contains only cones, the most central being very slender and concentrated; outside this the rods appear and gradually become more numerous until 4 or 5 mm. from the fovea three or four rods lie between every two cones.

Only at the optic nerve-head and the ora serrata is the retina firmly attached to the wall of the eyeball, elsewhere the rod and cone layer lies somewhat loosely on the pigment epithelium, which adheres to the choroid and separates from the rods and cones in retinal detachment. In detachment of the choroid or elevation of the retina by pathological changes in the choroid, the pigment layer is not separated from the rest of the retina.

The conducting stratum contains the layer of ganglion cells and the nerve fibre or innermost layer. The ganglion cell layer is much thicker in the central area than elsewhere, and around the fovea the cells are heaped up, forming an elevated circular ridge *higher* on the *nasal* (papillary) side. The connections of these perifoveal cells with their cones slope inwards to the fovea so that each ganglion cell lies at a little distance from its cone. In the fovea itself there are no ganglion cells and the retina consists of pigment layer, cones and a few cells of the inner nuclear layer.

Around the entrance of the optic nerve the outer retinal layers thin off somewhat and terminate with a sloping edge. The rod cone layer extends farthest towards the nerve but without reaching it, so

that the area in which percipient elements are absent is larger than the area of the scleral foramen. In front of this ring of modified retina lies the thickest part of the nerve fibre layer, thinning rapidly as the fibres spread outwards.

The arrangement of the fibres passing from the ganglion cells to the optic disc presents features of extreme importance for the perimetrist.

In that portion of the retina which is on the nasal side of a vertical line passing through the center of the optic papilla, the nerve fibres are readily arranged, passing straight from the retinal periphery to the nasal side of the disc. Thus any group of fibres, which lie in juxtaposition at the nasal edge of the disc, regarded collectively, forms a cuneate or fan-shaped bundle. Such a bundle contains fibres from a sector of the retina, its widest part corresponds to an arc of the periphery and its apex lies on the disc edge. Its size depends on the number of fibres included. Such a group is, therefore, not a true anatomical unit, as there is no segregation by septa or otherwise into groups of this kind but pathological influences frequently pick out such bundles of fibres. They form very convenient and important descriptive units and are known as nerve fibre bundles.

On the temporal side of what we may call the papilla line the fibres traverse an arcuate course from the periphery to the disc curving over and under the central area, which is in this way encircled.

Extending from the fovea horizontally outwards to the temporal edge of the retina is an invisible line which is not crossed by any nerve fibres and which is known as the horizontal raphe of the retina. The nature of this raphe is most clearly grasped if we look upon it as a fold in the temporal margin of the retina drawn horizontally into the centre, the fovea being at its apex and its edges falling into apposition (Roenne 225). In this sense the raphe may be regarded as a part of the retinal periphery and the macula as really situated upon the retinal edge. Those fibres which pass from the upper and lower parts of the temporal retina are only slightly curved; as the horizontal meridian is approached the arching becomes more pronounced and the fibres from the raphe and its neighborhood traverse an almost semicircular course. The macular fibres are short and less curved, those lying near the horizontal meridian passing practically straight to the temporal side of the optic papilla. The nerve fibre bundles on the temporal side of the disc are therefore in all essentials similar to those on the nasal side; they pass from the periphery, if we regard the raphe as a fold in the periphery, to the papilla, are fan-like or cuneate in shape but they are curved, whereas the nasal bundles are straight.

Thus the portion of the retina on the temporal side of a vertical line passing through the papilla contains arching fibres and is divided into upper and lower quadrants by the raphe and an imaginary line

continuing it to the disc, while the portion on the nasal side of the papilla line contains radiating fibres and is undivided. In addition to this local anatomical distribution of the nerve fibres there is a cerebral distribution to the four quadrants of the retina whose boundaries intersect in the fovea. The fibres from the upper and lower temporal quadrants constitute the uncrossed bundle which passes to the tract and cortex of its own side. Those from the nasal quadrants form the crossed bundle which crosses at the chiasma to the visual centres of the opposite side. From this arrangement we see that the uncrossed bundle is represented in the retina entirely by the longer arching fibres from the temporal side of the vertical meridian, while the crossed bundle contains the straight radiating fibres from the retina on the nasal side of the papilla and also the arching fibres from the area between a vertical line through the disc and the vertical meridian of the retina. The retina around the papilla is entirely supplied by crossed fibres and both crossed and uncrossed fibres enter into the composition of a complete arching bundle extending from the temporal raphe to the optic nerve."

Peters gives us concisely the blood supply of the retina as follows: "The outer neuron, or rod and cone layer, receives its nourishment from the choroid, i. e., from the chorio-capillaris. The other retinal layers are supplied by the main retinal branches of the central artery of the retina. The outer neuron, therefore, is distinctly separated in its blood supply from the middle and inner neurons and is dependent upon the choroidal circulation for its activity. The great detour which branches of the central artery of the retina must make in order to reach the extreme temporal region of the retina also has a bearing upon the early loss of the normal field in certain pathological conditions."

We will now follow Peters with regard to the visual pathway from the retina: "The optic nerve proper extends from the retina to the chiasm. It is about 5 cm. in length; 3.5 cm. of it is within the orbit and 1.5 cm. is within the optic foramen and the skull. The part within the sclera or the free intraocular end of the nerve is known as the disc or papilla. Within the papilla the nerve fibres are non-medullated, but from the eyeball to the chiasm the nerve fibres are medullated throughout. The relative position of the fibres from the retina is maintained in the optic nerve; that is, fibres from the temporal region of the retina occupy a temporal region in the nerve; those from the upper part of the retina are in the upper part of the nerve, etc. In fact, this arrangement is present in the chiasm, and as we shall see, to some extent in the cortex of the brain. The nerve is covered by three sheaths which are continuations of the brain coverings, namely, the dural, the arachnoidal and the pial coverings. The dural or outer covering is a hard membraneous tissue attached to the sclera and in part is continued forward as Tenon's capsule. At the optic

foramen it is closely adherent to the periosteum. Between the pia and the arachnoid and the arachnoid and the dura, are the subarachnoid and the subdural lymph spaces. These are continuous with the same spaces within the brain and in increased intracranial pressure these spaces are frequently distended with fluid, a factor which enters into the production of papilledema.

In the orbital cavity, the nerve lies loosely in the areolar tissue but in the optic foramen, accompanied by the ophthalmic artery, it occupies rather snugly this bony canal. At this point also it is in close juxtaposition to the sphenoidal sinus, which is separated from it by a thin bony wall. These two points, the smallness of the bony canal or the optic foramen and the proximity of the sphenoidal sinus, are predisposing factors in the easy production of retrobulbar neuritis.

The optic nerve consists of numerous nerve fibres (estimated at 1,000,000) bound together in bundles. Centrally located, but indistinguishable in the normal nerve from the other bundles, is the papillomacular bundle which furnishes us with a direct path between the macula and the primary optic centers in the brain. In a normal nerve, these fibres are indistinguishable but in certain forms of toxic amblyopia with central scotomata, degeneration of the optic tract has been traced from the eyeball up to the primary optic centers. From the primary optic centers the papillo-macular path to the cortical macular centers is not so clearly defined. That such a path does exist, however, continuing from the primary optic centers to the cortical macular centers has been established beyond any reasonable doubt. The exact position of this macular bundle in the optic nerve is of some importance. As it leaves the eyeball it is situated to the outer side of the nerve but as it approaches the optic foramen it is fairly centrally located, a position which it maintains in the chiasm, where the fibres divide with the other fibres of the nerve and in the optic tract as far as the primary optic centers. The shape of the papillomacular bundle is also of interest. Just back of the eyeball it is triangular in shape and is to the temporal side. Midway between the eyeball and the chiasm it is round and near the chiasm it is horizontally oval, about two to one. In the chiasm the oval appearance increases and after it leaves the chiasm it again assumes a round form.

About 1.5 cm. of the optic nerve lies within the skull. At this point the nerves unite to form the optic chiasm. In man the fields overlap and binocular vision includes a large part of our visual field. The number of crossed fibres in the chiasm is therefore relatively decreased. The relation of the crossed and uncrossed fibres, according to Weeks, is three to two. According to Bernheimer the crossed fibres are located in the lower part of the chiasm and the uncrossed fibres in the upper part of the chiasm.

The immediate anatomical environment of the chiasm is quite as important as the chiasm itself. It is slightly above the groove of the sphenoid bone. Posterior to and beneath it is the sella turcica, in which rests the pituitary body. Directly in the posterior angle of the chiasm is the infundibulum or process which connects the pituitary with the brain. Directly over the chiasm is the anterior tip of the third ventricle and to either side are the internal carotid arteries. In this minute space, therefore, are many important structures which frequently become the seat of disease and the optic commissure is usually involved.

From the optic chiasm visual fibres pass along the optic tracts which are formed by the union of uncrossed fibres of one eye and crossed fibres from the opposite eye, including the papillo-macular bundle. The tracts bend around the outside of the cerebral peduncles and become a part of the midbrain structure as they pass into the primary optic centers, namely, the external geniculate body, the pulvinar, or the tip of the optic thalamus and the anterior corpus quadrigeminum. It is claimed that at least 80 per cent of the fibres of the optic tract pass to the external geniculate body. A matter of much clinical interest is the relative location of fibres which represent corresponding retinal points. Are they immediately brought together after leaving the chiasm or are they indifferently placed in the optic tract without regard for their associated function? Up to the present time this point has not been definitely determined. In fact there is no positive assurance that associated fibres are brought into close contact before they reach the cortical centers in the cuneus. From our knowledge, however, of the orderly and systematic arrangement of fibres of the visual pathway, it is reasonable to conclude that they are in close contact immediately after they enter the optic tract.

Tracing the paths from the retina to the primary optic centers has been much simplified as the result of diseased processes. Paths from the primary centers to the higher cerebral centers in the brain are attended with much difficulty. It is justifiable to conclude, however, from the numerous sources of information at hand, and making allowance for errors, that from the primary optic centers there is direct communication with the fore-, mid-, and hind-brain. These paths of communication are established through the optic radiation. The bundle of nerve fibres collected from the primary centers passes through the extreme end of the internal capsule and thereafter spreads into a fan-shaped formation known as the optic radiation. So many reliable investigators have traced these paths that it is now generally accepted that a large number of fibres end in the cortical cells in and about the calcarine fissure. Others have been traced to the outer surface of the lobe as far as the angular gyrus. These latter so-called higher optic centers are without doubt an important part of the visual pathway in man.

From our present knowledge, gained by experimentation and by studies in morbid conditions, we are led to believe that this is the area of psychic vision—a storehouse of memory pictures which aid us in properly interpreting and modifying the concept which is formed from the nerve impulses which are carried to the cells about the calcarine fissure.

The course and distribution of the optic radiation in its relation to the several areas of the posterior part of the hemisphere have distinct localizing value in disease. In the anterior part of the radiation, the close proximity of the motor and sensory paths explains the frequent association of motor and sensory disturbance on the side homolateral to the hemianopsia or contralateral to the lesion. In studying the course of the optic radiation, Meyer was able to trace three distinct bundles or paths of fibres—dorsal, lateral and ventral. The dorsal and lateral fasciculi pass directly to the occipital cortex. The ventral fibres arch forward, forming a loop, which extends as far forward as the anterior end of the temporal horn of the ventricle in the temporal lobe, then turn backward to the anterior part of the inferior calcarine cortex. Temporal lobe lesions may, therefore, be associated with hemianopic visual disturbances.

Lesions in the occipital lobe as a rule produce complete or incomplete forms of homonymous hemianopsia without either motor or sensory phenomena.

The triangular body in the extreme posterior end of the hemisphere on the mesial surface, known as the cuneus, is now accepted as the location of the cortical visual centers. For a time there was some difference of opinion as to the exact extent of the visual area. It is now generally believed that the centers concerned with sight are within the area bounded by the line of Gennari. The area is divided by the calcarine fissure. This fissure is constant in man and is not one of the many irregular fissures which happen by chance to separate the convolutions. It is now understood that the upper parts of the retina are represented in the upper part of the calcarine fissure and the lower parts of the retina in the lower part of the calcarine fissure.

Studies of war injuries by Holmes and Lister and others confirm these conclusions. These same studies also definitely locate the macular cortical centers in the posterior tip of the visual area on the marginal and inner lateral surface of each occipital lobe (Weisenburg). Peripheral parts of the retina are represented in the anterior end of the calcarine fissure and intermediate parts of the retina between macula and periphery are represented in serial order from the posterior pole of the hemisphere to the anterior end of the fissure.

While it is definitely determined that the macular cortical centers are in the posterior tip of the hemisphere, the question of unilat-

eral or bilateral representation has been much debated. The consensus of belief is in the form of bilateral representation. For example, the right cortex represents macular vision on the right side of each retina and the left cortex that of the left side of each retina. A superficial lesion in the posterior tip of the right macular centers will produce a macular or minute central hemiscotoma in both visual fields to the left.

Although Adolph Meyer endeavored to show that the three segments of the optic radiation traced by him, were uniform throughout and therefore probably did not send fibres to the cortex around the angular gyrus on the outer surface of the occipital lobe, there is no doubt of communication between the visual centers in the calcarine cortex and the centers known as psyhic centers. Lesions which intercept or cut off this communication are accompanied by mind-blindness. These centers are essential to and a part of the psychological phase of vision.

Just what occurs in the visual act is best explained by Lohman. He divides the act into (a) a physical phase, which Peters has called a physico-chemical phase. This includes the dioptric parts of the eye and the receptive end-organs of the retina, or rods and cones sensitized by the visual purple. (b) The physiological phase or that part of the optic tract from the rod and cone layer of the retina to the cortical or higher centers in the hemispheres, in which the light stimulus is transformed into a nerve impulse. (c) The psychological phase, which takes place in the cortex of the brain.

Perimetry is only indirectly concerned with the dioptrics of the eye. One must take into consideration refractive errors of considerable degree, as such errors, if not corrected, may interfere with the proper "taking" of the field. The purely physico-chemical act must, however, be thoroughly understood in order to correctly interpret abnormalities."

Rays of light entering through the pupil project upon the retina an inverted image. Through the medium of accommodation, the image becomes sharply focussed upon the retina. The effects of light upon the retina bring about a chemical change or disorganization which in time recovers itself. While not entirely beyond question, it is generally believed that the visual purple is the chemical substance upon which light acts and which renders the rods and cones sensitive. At all events, there is evidence to show that light produces a chemical change either in the visual purple or in some other chemical substance which has the power of recovering itself. Lohman concludes that the transforming of light stimulus to nerve impulse is probably a photo-chemical process. It is probable at least that the visual purple is an essential factor in this transformation.

"Just where the physico-chemical phase ends and the physio-

logical phase begins is equally interesting. Salzmann divides the retina into three cellular layers: (1) The outer or rod and cone neuron; (2) the inner nuclear neuron; (3) the ganglionic neuron. The physiological phase of vision probably begins with the second or inner neuron. Peters believes it to be more accurately correct to speak of the inner neuron as the point of transition of the physico-chemical to the physiological phase. This would correspond to conditions as we find them in the spinal cord. The ganglionic cells would coincide with the ganglionic cells of the cord. The present tendency is to consider a neuron as consisting of a cell with a prolongation or axis cylinder.

Little is definitely known about the exact functions of the inner nuclear layer but all concede that this neuron serves as a connecting link of the various nerve elements and processes of a high order take place within this layer. The third or ganglionic neuron, therefore, we will regard as the actual beginning of the physiological phase of vision. It is in contact with the inner nuclear layer by short processes and the axis cylinders extend from the ganglion cells to the primary optic centers at the base of the brain—the external geniculate body, the anterior corpus quadrigeminum and the tail of the optic thalamus. It is possible that this neuron is continuous even with the cortical cells in the cuneus.

Light stimulus, which now has been transformed into a nerve impulse, travels along the axis cylinders, through the optic nerve, chiasm and the optic tract to the primary optic centers. Impulses travel through the optic radiation from the primary centers to the cortex, in and about the calcarine fissure of the cuneiform body. Here the physiological phase ends and the psychological phase begins.

The psychic centers act as a storehouse of all visual sensations received by the individual. They serve a larger purpose than that of memory. A nerve impulse carried to the visual centers in the calcarine cortex by the transmitting neuron in the physiological phase of the visual act must be interpreted in order to form a concept. Any new sensation is modified or rendered intelligible only by comparing it with former visual impressions. This is made possible by the psychic or concept centers.

The concept is formed in the occipital lobe. It is reasonable, however, to suppose that other parts of the brain may be concerned in the psychological phase of vision.

A lesion which destroys the calcarine cortex produces blindness in homonymous halves of the fields. The patient is unable to see objects which fall in the blind halves of the visual field.

With this brief review of the generally accepted facts of anatomy and of the physiology of vision, we are prepared for a consideration

of normal fields and of the field changes which take place in disease of the visual pathway.

Vision is of a two fold character: (1) Central or that part which allows the eye to fix on a small object and (2) indirect or peripheral vision. When one fixes central or macular vision upon an object, it is possible at the same time to note with considerable detail objects situated remotely from the point of fixation. This is accomplished by indirect vision. The fovea in the macular region is regarded as the center of vision because of its great sensitiveness to clear perception. Visual acuity here reaches its greatest development and it recedes rapidly in the area immediately surrounding the fovea and less rapidly beyond until the periphery of the retina is reached. Central vision notes details of objects at rest but moving objects are observed with more accuracy by indirect vision. Similarly, although central vision is sharpest in good light, in peripheral parts of the retina, adaptation, or the ability of the eye to adjust itself to varying degrees of light, is more highly developed. It is therefore, necessary to study both central and indirect vision in the normal individual in order to have a standard with which to compare pathological or diseased conditions. Perimetry is especially concerned in a study of the projected indirect field although the macula and adjoining areas must also be studied carefully when central visual acuity has become impaired. Central visual acuity therefore is the first fact to be determined in beginning a perimetric study.

When visual impression is made upon the retina the image is not observed on the retina itself, but is seen in space. In order to understand the relation of points in space to points on the retina, a study of the laws of projection and direction is necessary. These laws establish the fact that every point in the projected field has a correlated point on the retina. The clinical application of this means that the upper of the retina receives impressions from the lower part of the field and vice versa; the right half of the retina receives impression from the left field and vice versa. In perimetry record is made of the defects of the field and not the location of the lesion. To mentally visualize the location of the lesion it is necessary to transpose.

As each point in the projected field bears a definite and fixed relation to a point in the retina, every point in one retina has a corresponding and definitely related point in the other retina, and these points are known as corresponding retinal points.

An image in space which falls upon corresponding retinal points makes an impression upon both retinas but the resulting impressions form but a single image.

What is true of corresponding retinal points is true also of larger parts of the retinae, as quadrants and halves of the retinae.

Various factors influence the size and shape of the field. The ac-

tivity of the retina. The bony prominence of the face and shape of the orbital cavity. The width of the palpebral fissure, the size and plane of the pupil and refractive errors. Also, factors of technic influence the size and shape of the field; intelligence of the patient, the influence of drugs, fatigue, effect of light, intensity and character of the stimulus and pre-exposure and surrounding field. The last mentioned factor is especially true in mapping the color fields.

Various investigators in their studies of the behavior of colors in testing retinal sensitivity differ in their conclusions as to the limits of the color fields. Ferree and Rand under ideal laboratory conditions and with spectrum colors have demonstrated that the peripheral retina is sensitive to red, blue and green to the extreme limits of form field. It is manifestly impossible to hope to obtain clinically the accuracy in technic which they were able to employ.

Ferree and Rand give the following average for the color field:

	Out	Down	In	Up
Blue	62	42	43	35
Red	60	40	40	32
Green	38	25	26	22

The optic nerve enters the eyeball about 15 degrees to the inner side of the macula and slightly above the horizontal plane of the macula. As in the nerve head or papilla, the rods and cones are not in evidence; this area is blind to all forms of visual impressions and, therefore, constitutes a blind spot known as the blind spot of Mariotte. In the field, this has been fixed about 15 degrees to the outer field and a little below the center of fixation. The inner margin is about 13½ degrees from the center of fixation, 5 degrees in width, 7 degrees in length and extends 2 degrees above the horizontal and 4 degrees below the horizontal meridian. Some investigators have found an area surrounding the blind spot in which color perception was lacking but this is usually difficult to detect. When such a zone is obtained by average methods, it may be looked upon as suspicious evidence of a pathological condition.

We thus have a picture of normal fields. Let us now consider general pathology of the visual pathway.

There are two characters of pathological changes which are noted in examination of visual fields: (1) Scotoma, or blind spots, and (2) changes in the size and shape of form and color fields. Either of these changes may be noted separately in a given case or they may be found in combination. Traquair distinguishes the two main groups as the contractions and the scotomata. A contraction or restriction is a defect which affects the periphery. When the contraction becomes extreme, the central area is involved. Contraction may be concentric or local.

A scotoma is a blind spot which appears in the visual field. The

blind spot of Mariotte is the only area in the field of the normal eye which may be regarded as normal, as it represents the entrance of the optic nerve into the eyeball—an area in which the rod and cone elements are absent. Any other areas within what may be regarded as normal limits of vision for a given patient are pathological; and represent alterations in function or structure of parts of the visual pathway. They may be small or large, regular or irregular in outline, distinct or indistinct, as the lesion which cause them will determine.

In order to be specific in describing the character of blind areas, we classify scotomata, first, as indistinct, relative and absolute.

Occasionally a scotoma is indistinct in outline, i. e., the patient is unable to define a sharp line of demarcation between the point of clear vision and the absence of vision. Surrounding a relative blind spot, this is especially well illustrated. In a blind area for green, for example, the color does not sharply disappear as the blind spot is approached but it shades off into a paler green, becomes white and is finally lost. The periphery of a scotoma, therefore, is surrounded by an indistinct zone and we speak of this area as an indistinct scotoma. The entire partially blind area may be of the same general character, in which green for example, may not be recognized as a color, or in which even form may be hazy and uncertain. This latter variety should also be classified as indistinct. In fact great care and exactness in the choosing of terms which we employ in describing definite conditions, is essential to a clear interpretation.

A relative scotoma is an area in which form may be seen but in which one or more colors—blue, red or green—are not recognized. The uniform method of charting a relative scotoma is by parallel lines drawn in a horizontal or vertical direction.

An absolute scotoma is a blind area in which the patient cannot perceive form, color or light. It is a totally blind area in which light sense is totally absent. In charting this form of blind spot, it is universally drawn by crossed horizontal and vertical lines.

The difference between an indistinct, a relative and an absolute scotoma is practically one of degree. In the course of development, if the process is not too acute, an indistinct area develops first, followed by relative changes and finally a blind area appears which is absolute. In recovery, too, before function is completely restored, an absolute scotoma will become relative; or if recovery remains incomplete, a relative or an indistinct blind area may remain. The completeness or the incompleteness of a scotoma, therefore, enters not only into the diagnosis but into the prognosis as well.

A second classification is that of positive and negative scotomata—a classification which is frequently confounded with that of

relative and absolute. The characteristics here are totally different. A positive scotoma is a blind area in the visual field which the patient sees entoptically—a black or gray area which the patient can clearly outline and of which he will complain. A negative scotoma, on the other hand is not recognized by the patient and is only elicited by careful examination on the perimeter. A positive scotoma may in time become negative, i. e., after a considerable period of time the patient may become so accustomed to the presence of the blind area that he is no longer conscious of it. Floating masses in the vitreous give rise to positive scotomata in the visual field but in time they may disappear from the patient's consciousness, and no longer interfere with vision. The classification, however, has a deeper significance. Positive scotomata usually mean a lesion or lesions, which prevent the formation of an image on the rod and cone neuron, as, for example, a dense hemorrhage in the retina or vitreous, disturbance of the choroidal circulation, or circumscribed disease of the choriocapillaris which supplies nourishment to the rod and cone elements. Under these circumstances, the blind area is likely to be positive. On the other hand, a negative scotoma usually is associated with disease of the neurons, the ganglionic elements, or of the axis cyclinders. In recent cases this location of the lesion by the positive or negative character of the blind area, may, in a majority of cases, be depended upon. In cases of long standing, however, a positive scotoma may become negative, as explained above.

It must be clear also that negative scotomata may be indistinct, relative or absolute.

A third classification may be made in reference to position, that of central and peripheral. A central scotoma is one which includes the macula, a condition which is common in retrobulbar neuritis or toxic amblyopia in which the papillo-macular bundle of nerve fibers is diseased. Peripheral scotomata, as the name implies, are found in peripheral parts of the retina. When in the center or intermediate zone, that is up to the 40th degree from the center, they are readily recognized by perimetry; but when in the extreme periphery, where the retinal elements require strong stimulation in order to receive a visual impression, they are often overlooked unless searched for carefully.

Scotomata in the central zone may be subdivided into pericentral (around the macula) or paracentral (along-side of the macula).

If a scotoma includes the blind spot of Mariotte and the macula, it is sometimes spoken of as a caeco-central scotoma—a convenient term which is self-explanatory and brief.

The normal blind spot varies within normal limits, depending upon anatomical differences, types and physiological variations. The shape of the average disc is oval with the long axis in the vertical.

The exact shape of the blind spot, however, depends upon the attachment or the extent of the choroid and retina. The retina may be close to the scleral edge in one part and somewhat distant in another. This irregularity will naturally cause an irregularity in the shape of the blind spot.

The direction in which enlargements take place is of much importance. In myopia for example and in toxic amblyopia, the enlargement is toward the point of fixation. In Glaucoma enlargements are observed from above and below and toward the center of fixation—the so-called Seidel sign. The increase in this instance is in the direction of the nerve fibers which pass above and below the macula toward the raphe. In sinus disease the enlargement is more or less concentric, like an iris diaphragm.

Enlargement of the temporal border should always be studied most carefully, as it is in this area that the patient finds the greatest difficulty in giving decisive answers. There are two reasons for this, if very small test objects are used. In the first place the outer edge of the optic disc is 5 or 6 degrees further from the center than is the inner edge. This part of the retina is relatively less sensitive to low or medium intensities of stimulation. A second reason may be found in the fact that nerve fibers and blood vessels are pushed to the temporal side of the disc and while they should not decrease the relative sensitivity of the retina, many superimposed fibers may contribute some to rendering the immediate zone a little less sensitive than other areas adjoining.

Abnormal positions of the blind spot, i. e., a blind spot displaced out or in, can hardly be called pathological. Excepting in myopia, in which the blind spot is apt to be nearer to the point of fixation than normally, such displacements should be regarded as physiological or anatomical variations.

If by the ordinary clinical methods the size of the blind spot shows an increase of two degrees this should be regarded as pathological, especially if the other eye does not show the same increase in size or the ophthalmoscope does not reveal a disc of unusual proportions.

Considering now the characteristics of field changes in specific pathological disturbances of the intraocular portion of the visual pathway, let us confine ourselves to those conditions in which perimetry may be of particular value.

In many instances of incipient diseases of the choroid and of the retina the ophthalmoscope does not disclose their presence. Shrinkage or loss of the blue field out of proportion to the red and green is characteristic of choroidal disturbance involving the rod and cone layer of the retina. On the other hand contraction of the red and green with fairly normal blue and form fields indicate changes

in the inner layers of the retina and the ganglionic axis cylinders of the optic nerve. Another difference observed perimetrically between disease of the choroid involving the outer layers of the retina and disease of the inner layers the retina is the character of the scotoma when present. Involvement of the choroid and outer or rod and cone layer may be evidenced by a positive scotoma, while primary disease of the ganglionic cells and their axis cylinders is accompanied by a scotoma which is negative in character. Multiple scotomata distributed over the field is characteristic evidence of choroiditis. These scotomata in the macular area which coalesce so as to form ring scotoma indicate syphilitic choroiditis.

Retinitis is primarily an inflammation of the ganglionic cells and their axis cylinders and is generally a diffuse condition. There would be therefore a contracton of the form and color fields with a greater contraction of the red and green. As retinitis is of various forms such as syphilitic, nephritic, diabetic, retinitis pigmentosa and leukemic, various field changes are characteristic of each and a careful study should be made of these. Time will not permit taking up the details here.

I should speak of Detachment of the retina. In the early stages the patient may be conscious of a cloudy area. Perimetry will disclose an indistinct scotomatous area; qualitative blue changes is one of the earliest symptoms. After the retina becomes separated an absolute scotoma appears and there will be an indistinct scotomatous area surrounding the absolute scotoma (cite case).

In considering changes involving the nerve head we may include papillitis, choked disc and glaucoma. We shall discuss only that of glaucoma as in this disease its detection in the incipient stages is imperative.

One of the earliest changes in the visual field in glaucoma is a nasal contraction. This is true of both acute and chronic forms although due to different secondary causes. Of course the intraocular pressure is the primary cause but in the acute stage the loss of nasal field is due to constriction of the circulation or vascular obstruction, while in the chronic stage of non-inflammatory type it is due to nerve fibre block or degeneration.

In chronic glaucoma the usual sequence of field manifestations are (1) early loss of nasal field, (2) sector like defects of the upper or lower nasal quadrants, (3) enlargement of the blind spot or Bjerrum's sign, (4) concentric contraction of form and colors, (5) preservation of central vision for form and colors, (6) almost complete loss of peripheral field with preservation of small central island of vision, (7) total loss of central vision.

Peters has found that in order to detect the first indication of Bjerrum's sign a small green stimulus is best. The scotoma is at

first indistinct for green, then relative in which green is lost first and finally it becomes absolute.

Seidel's Sign is a phase of Bjerrum's sign being a crescent shape defect usually appearing as a spur above or below the blind spot of Mariotte and arching toward the nasal periphery.

These signs are the earliest field changes observed. Sometimes however these are not detected until contraction for form and color has taken place.

In chronic non-inflammatory glaucoma the patient many times does not suspect trouble because of the retention of central vision. It is therefore our clear duty to look closely for the early signs in all cases where there is a suspicion of glaucoma.

The retrobulbar portion of the optic nerve is subject to two types of disease—inflammation and atrophy. If there is a central scotoma, the papillo-macular bundle is involved. If there is contraction for form and colors with a tendency to sector-like defects the cause is a diffuse interstitial neuritis. As most forms of optic neuritis furnish unmistakable ophthalmoscopic pictures we need not do more than point out the necessity of completing the picture of such cases by mapping the fields.

Just a word on Primary Optic Atrophy. This arises from pathological processes due to various causes but the best example is that of Tabes Dorsalis. Early and rapid loss of red and green fields, concentric contraction of form and blue fields are characteristic symptoms. These changes usually occur in the nasal field first. Negative central scotoma may occur. Relative at first and soon becoming positive.

Perimetric symptoms of pathology of the chiasm are bitemporal and binasal hemianopsias, irregular hemianopsia, and altitudinal hemianopsias, resulting from disease of one or more of the structures lying closely to the chiasm—the meninges, the infundibulum, the pituitary body, the anterior end of the third ventricle, and the internal carotid arteries.

Changes of the fields due to disease of the optic tracts and primary optic centers are definite, but we will not discuss them here as a discussion of toxic amblyopia is more important from our standpoint.

In general the field defects of toxic amblyopic are central, the onset is usually rapid and the tendency to recovery is almost always a prominent feature, but there may be peripheral depression or a combination of both.

Of the exogenic poisons tobacco is probably most frequently the causal agent, but lead, carbon-bisulphide, arsenic, and others produce field changes. These are included in the group which tend to produce

peripheral neuritis. Certain endogenic poisons such as those found in diabetes and beri-beri also produce central scotoma.

Other toxins such as quinine and salicyclic acid form another group that produce field changes in the nature of peripheral and general depression while central scotoma is rare.

Tobacco amblyopia is the best example of the scotomatous group. The field defect is always characteristic. In shape it is horizontally oval and centro-caecal in position. The defect is always bilateral and may be more developed in one field than the other. The edges of the scotoma are sloping and the defect for color exceeds that for white.

Brombach gives us most interesting data, as a result of his exhaustive research, on the effect of toxins. He demonstrates definite changes in color field perception which if field charts are made both morning and afternoon of the same day will determine whether the amblyopia is due to toxins of the stimulative type or to those of the depressive type. Also whether they are of primary or secondary type or of focal infection type.

Time will not permit of further discussion of this interesting subject. In conclusion let me state that the following is my personal estimate of perimetry. "It is a subject so vast and so important that we must develop specialists in this line."

A proper perimetric examination takes time and a high degree of skill and the interpretation of field changes requires accurate observation based upon a proper knowledge of anatomical, physiological, pathological and psychical factors.

When should an analysis of the fields be made? My answer is as follows:

1. When refractive media is free from opacities but correction of refractive error does not produce normal vision.
2. When symptoms of discomfort are not relieved by correction of refractive error.
3. When phorias do not respond properly to lens correction.
4. When ophthalmoscope reveals pathology requiring reference of patient for medical diagnosis.
5. All tropia cases.
6. All progressive and highly myopic cases.
7. All trouble cases.

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"MEASURING SQUINT"*

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Various ways have been devised to estimate or measure the angular deviation of a pair of squinting eyes. Due to the absence of binocular simultaneous perception such methods have to be objective and depend for their accuracy on the patient's intelligence and on the operator's skill. The writer once described a method reported in this Journal and later found to be too elaborate for manufacture and routine use.[1] He since has devised a simpler way using a popular optometric instrument capable of far greater accuracy in the majority of cases than any other instrument or method now in use.

Tangential measurements of ocular deviations are *per se* more accurate than angular measurements, as the tangent values of the larger deviations are more than twice the angle. The prism diopter is now in universal use as the unit of prism measurement. Why not adopt that unit for ocular deviations instead of degrees or centrads, inasmuch as these same deviations are corrected by prisms constructed on the Prentice rule? Applying this rule to the Cameron Myologic Unit, it is possible to measure ocular deviations within one degree whereas other methods are not accurate to within 5 degrees + or —.

A clearer understanding of the method will be had by restating the following axioms:

1. The majority of squinters suppress the image of one eye or the other, both eyes being uncovered.

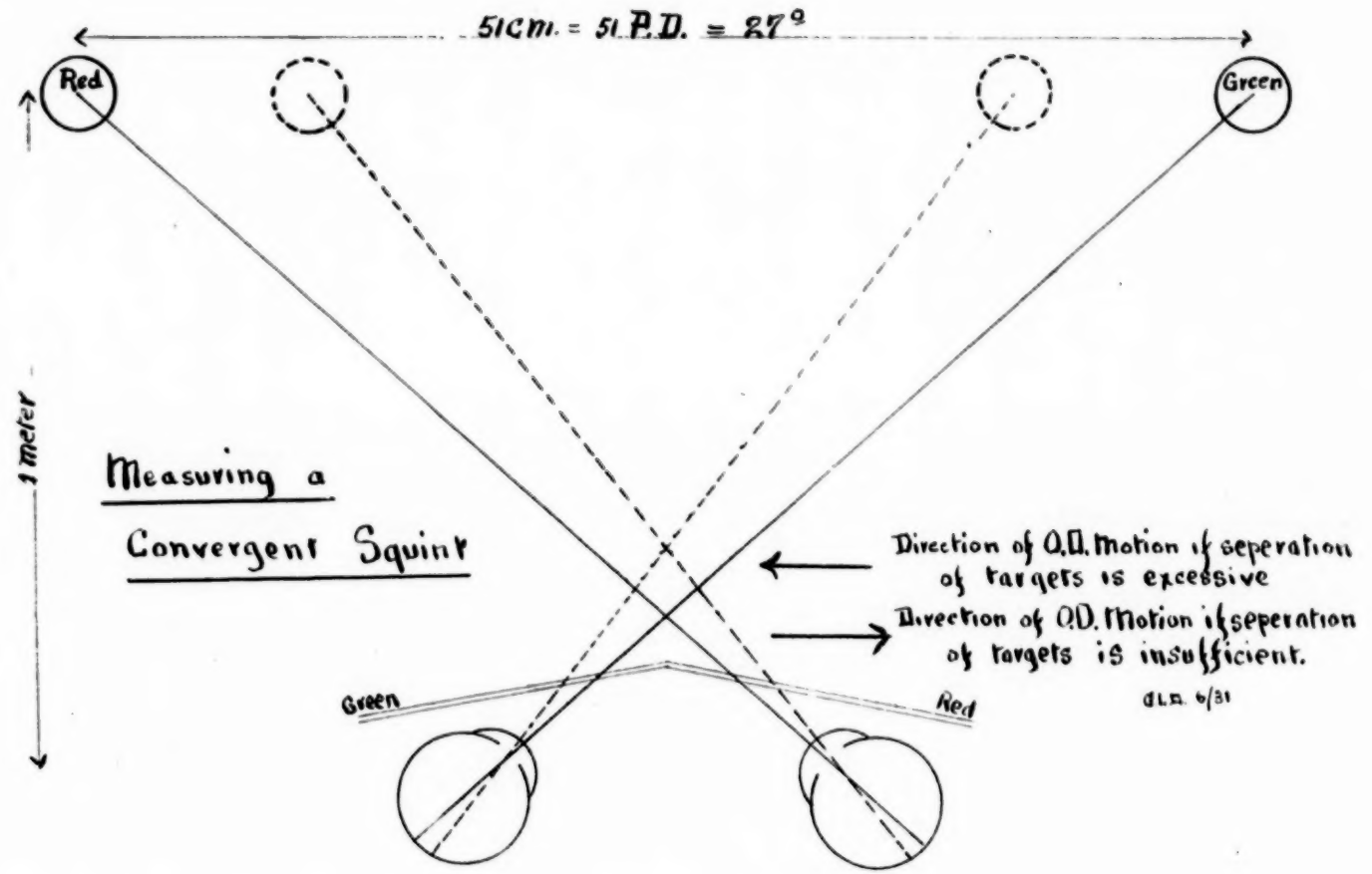
2. They are capable of monocular alternate fixation with one eye covered, except the pathologic and high amblyopic cases.

3. They generally falsely project the non-macular image of the squinting eye, both eyes being uncovered.

4. In many, some rudiment of fusion is developed between the true and the false image. (False macula?)

*Submitted for publication July 3, 1931.

[1]American Journal of Optometry, March, 1929.


51cm. = 51 P.D. = 27°
Red
Green
1 meter
Measuring a
Convergent Squint
Direction of O.U. Motion if seperation of targets is excessive
Direction of O.D. Motion if seperation of targets is insufficient.
Green
Red
dLR. 6/31

We exclude the paralytic and occasional squints. The majority of squinters within the scope of orthoptic treatments have concommitance or the ability to fixate with either eye when the other is covered, it is only in cases of high amblyopia or large central scotomata that their fixation is not correct. In such cases this technique is not dependable. However, said cases need not be measured until further progress as such information would be of no use in the curing of the squint. In other cases true monocular fixation can be developed very rapidly following which this test can be made, supplying the information needed for the completion of the case. The instrument in question consists primarily of two projection tubes and lamphouses with synchronized illumination controlled by a motor. These two tubes project similar characters, each a green or red, both complementary to each other. The separation of these characters on the screen is variable, and they can be made to flash on and off simultaneously or alternately, at variable speeds.

In front of the patient's eyes are placed complementary glass filters identical to the complementary images or anaglyphs projected on the screen; dissociation of the fields is thus obtained, the right eye seeing only the red character, the left eye only the green. It is possible to observe the patient's eyes through the sides of the scopes.

The complementary images are projected on the screen so as to correspond approximately to the direction of the patient's visual axii. If this adjustment were correct, each letter seen would fall on the macula of its corresponding eye. However, the squinter is unable to see them both at the same time, therefore the flashing motor of the instrument is started and the two characters are slowly and alternately flashed on the screen. A light (shielded not to interfere with the patient's fixation) is held under the complementary glass or scope, and the motion of his eyes is observed as he fixes alternately with right and left eye the two alternating characters. As can be seen on the schematic diagram, if the two characters are flashing too close together each eye will have to alternately turn nasalward in order to fixate, whereas, if they are too far apart the eyes will alternately turn temporalward, thus by altering the position of the two images we find a position where no perceptible motion of each eye is necessary to fixate. The movement of the eyeball in such motion is easily discernible, and with a little practice quite accurate results can be secured.

In this test the patient's eyes are 1 meter from the screen, therefore by Prentice rule each centimeter of separation between the two characters is equal to 1 prism diopter of deviation. A prism diopter is equivalent to the tangent value of its angle multiplied by one hundred, i. e., P. D. $=$ tang. d $\times$ 100. Any four decimal natural function table will give the prism diopter value of an angle or the

angular value of a prism diopter. A simple rule for transposing prism diopters to angles is to multiply by 4 and divide by 7. To transpose degrees into prism diopters multiply by 7 and divide by 4. However, this is only fairly accurate for degrees less than 15. As an ocular motion of a couple of degrees is easily discernible we are justified in considering the technique accurate within 1 degree. The writer has had an occasion to prove this to himself and others, by measuring the deviations in cases where diplopia was readily obtained and placing the indicated amount of prism base-in or out as the case required. Binocular single vision was obtained and to prove it a vertical displacing prism when placed before the eyes, doubled the image into two, one directly above the other.

Prism diopter equivalent of degrees, to the nearest half diopter. + and — signs indicate a little more or a little less than the figure they follow.

Degrees	Prism Diopter	Degrees	Prism Diopter
1°	2.00—	24°	44.50+
2°	3.50+	25°	46.50+
3°	5.00+	26°	49.00—
4°	7.00—	27°	51.00—
5°	9.00—	28°	53.00+
6°	10.50+	29°	55.50—
7°	12.50—	30°	57.50+
8°	14.00+	31°	60.00+
9°	16.00—	32°	62.50—
10°	17.50+	33°	65.00—
11°	19.50—	34°	67.50—
12°	21.50—	35°	70.00+
13°	23.00+	36°	72.50+
14°	25.00—	37°	75.50—
15°	27.00—	38°	78.00+
16°	29.00—	39°	81.00—
17°	30.50+	40°	84.00—
18°	32.50—	41°	87.00—
19°	34.50—	42°	90.00+
20°	36.50—	43°	94.00—
21°	38.50—	44°	96.50+
22°	40.50—	45°	100.00
23°	42.50—		

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PROGRESSIVE MUSCULAR AND NERVE ATROPHY DUE TO BRAIN TUMOR

The following is a report of a case which recently came under my observation. While this case is distinctly of a pathologic nature, still there are several diagnostic points of interest of value to an optometrist.

Mrs. A. H., 68 years of age, was brought to my office for an ocular examination December 23, 1930. History: Her general health was good until recently. She had eight children, all living but one. Her chief complaint was dizziness. This was especially bad when she first tried to change from a sitting to a standing position. If some one helped her to stand up and steadied her for a few moments, she was then able to stand up by herself and walk for a short distance without any assistance. If she tried to stand by herself, she had a tendency to fall over to the *left side*. Her sight, she complained, was failing her.

The left eye turned out completely to the temporal side and was about 80 per cent closed. She practically had no control over its lateral movement. The right eye appeared normal externally with the exception of a slight amount of turning to the right temporal side. When asked to look with that eye to the nasal side she could bring it into the *median line only*, indicating that the right internal rectus was also involved.

This condition she claimed became first manifest about three months ago and was getting worse gradually until diplopia set in.

She had been for an examination and observation at one of the leading hospitals in Minneapolis and was finally prescribed a pair of single vision glasses and discharged. Not noticing any improvement, she went to a local ophthalmologist who told her she needed different glasses and prescribed a pair of bifocals O. U. + 100 D. S. with a + 3.00 D. S. addition. These also proved of no value. When she came back to him and complained of the diplopia, he told her that it would disappear as soon as she got used to the glasses. Two or three weeks later, she called again and complained of her dizziness and diplopia. He then put a blinder over the left eye. This of course, illuminated the diplopia but her condition continued to get worse. Her vision without lenses was O. D. 20/25, O. S. 20/100—with lenses. O. D. + 1.00 D. S. V. A. 20/20; O. S. + 1.00 D. S. V. A. 20/40. The pupillary reaction to light was somewhat sluggish. Ophthalmoscopic examination was negative. With great difficulty, a color and form field test was made and it revealed a marked contraction and interlacing of both form and colors and the contraction was typical of the brain tumor type.

From this examination, I suspected that the patient may have brain tumor and concluded that this was not a refractive case. Accordingly, the patient was sent to a reliable physician for a complete physical examination with a request for a detailed report. The report was negative. Many spinal punctures were done and X-rays made of the skull. All were negative. The physician advised that I try to give her electrical diathermy treatments as he thought that this might be of some help to her. I told him that I suspected a brain tumor and for this reason I did not wish to treat this case. However, if he cared to treat the case, I would co-operate with him and teach him the technique but before he started the treatments I wanted to get a report from a neurologist.

January 2, 1931, the patient was sent to a neurologist for an examination and on the sixth we received the following report: "*Condition apparently due to involvement of the cranial nerves at the exit from skull.* Further study necessary to determine." Two other neurologists were called in on the case and after some study and observation, the diagnosis was rendered as "progressive muscular and nerve atrophy," cause undetermined. I then turned the case over to the physician for general and ocular diathermy treatments and the patient was sent back to me at intervals for an examination to determine whether the treatments were helping any. Treatments were given three times a week on alternate days.

January 21, 1931, my examination revealed O. U. ophthalmoscope

negative; O. D. vision without lens 20/25 O. S. 15/200. Right eye turned out about the same amount as before. The up and down movements seemed also to be affected. Left eye closed completely. After consulting with the physician, we decided that he continue the treatments for a longer period and then send her back for another eye examination.

On February 7, 1931, my examination revealed that her ocular as well as her general condition was definitely worse.

Vision O. D. was 20/50. The right eye turned out considerably more to the temporal side than before. It was also about 60 per cent to 75 per cent closed. She no longer could stand up even with the help of others. She actually had to be carried.

After consultation with her physician, it was decided that the treatments were of no help and she was advised to discontinue them.

Her condition became worse right along until by the end of February she was practically all blind and paralyzed, although she never complained of pain. Her dizziness increased, she became somnolent and finally unconscious. She was taken to the hospital on March 2, 1931, and died at 6:30 P. M. the same day.

An autopsy was performed by some members of the hospital staff and the findings were as follows:

"The scalp and calvarium are normal. The brain bulges thru the dura when it is incised. There is no flattening of the convolutions and when the brain is removed there are no pressure cones around the hypophyseal region or the medulla. There is a marked amount of fluid under the arachnoid. When the corpus callosum is split the basal ganglia of the left hemisphere are found bulging into the 3rd ventricle. Section of the brain does not reveal any abnormal mass except that a definite hardness is found over the basal ganglia which differentiates this region from the rest of the brain. No other local changes are found.

Microscopic examination of the basal ganglia shows increased number of neuroglia cells and fibres; marked satellitosis of all the nerve cells; one giant cell is found, confirming the diagnosis of glioma.

Diagnosis

1. Glioma of the brain.
2. Increased intracranial pressure (fluid)."

Discussion

The points of interest in this case are:

1. The fact that extrinsic ocular muscles and nerves were first

attacked. The lack of the choked disc picture as well as the lack of characteristic symptoms of headaches, pain, etc.

2. The way the patient was fitted with glasses by the first hospital ophthalmologist and by the private ophthalmologist when the patient had a brain involvement and not a refractive condition.

3. That our field test gave us a better lead as to the possible cause of her trouble than the physical examination, X-ray and neurological test.

4. That the autopsy finding confirmed our original diagnosis of brain tumor.

J. I. K.

ARTIFICIAL SUNLIGHT, by M. Luckiesh, D. Sc., Director Nela Park Research Laboratories. Published by D. Van Nostrom & Co., Inc., New York City. 254 pages, 65 illustrations. Price, $3.75. 1930.

An account is given in this book regarding the latest developments in illumination, which the author calls "dual purpose lighting" by which he means lighting for HEALTH as well as for VISION. Luckiesh goes into great length in this book to show the biological effect of radiation not only as a cure for diseases but as a most important preventative agent. He maintains that the treatment of illness should be the territory of the medical profession; on the other hand, he contends that health maintenance is the responsibility of every art, science and individual who happens to be in a position to prevent illness and to safeguard public health.

A very complete account is given of the energy distribution of artificial light sources of various types and the comparison with energy distribution in sunlight under different atmospheric conditions and at different localities and seasons of the year.

A very large amount of material which is the result of his own investigation as well as of other scientists are contained in this book. This material is of special interest to the optometrists because it deals mainly with the absorption and transmission of radiant energy given off by the Sun, various artificial sources and by the new "Type S-1 Sunlight" lamp recently developed for dual purpose just mentioned. This lamp consists of a mercury arc between tungsten electrodes at the terminals of a tungsten filament. A pool of mercury is placed in the end of special bulb, which supplies mercury vapor for the arc.

There is a wealth of information in this book for the optometrist who takes the practice of his profession seriously. The material is so arranged that one need have little difficulty in studying this subject. Every progressive optometrist should make this book a part of his library.

J. I. K.

ANNOTATIONS AND SOCIETY PROCEEDINGS

The American Journal of Optometry is the Official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

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SOUTHEASTERN CONGRESS OF OPTOMETRY

The following notes were taken by Dr. Robert J. Pierce of Winston-Salem, North Carolina, at a recent meeting of the Southeastern Congress of Optometry. Dr. Pierce says in part, that these notes have not been corrected by the lecturers but to the best of his knowledge they are correct.

Neumueller on Ophthalmoscopy

Any toxic condition always reflects first in the fusion centers.

Frontal headaches is usual to hyperopes with good vision. Occipital headaches are usual to hyperopes with blurred vision.

One Wassermann is not certain.

Take the accommodative-convergence reflex from above.

Palpation of the eye is easy to take and important.

Use the ophthalmoscope first at 16 inches.

Determine the depth of opacities by parralax.

Do not mistake shadows for opacities. Opacities always show up black.

Second, turn in 16 diopter lens and examine from 2.5 inches.

Blepharitis is not a condition to be sent to the oculist.

Follicular conjuctivitis resembles trachoma.

The elevations in trachoma are at least twice as large as in follicular conjunctivitis.

Corneal involvements are always dangerous.

The most dangerous region of the eye is the corneo-scleral junction.

Cataracts should be seen every 6 to 8 weeks, as it is important to operate at the proper time, or glaucoma may set in.

Colabar glass was made to use in cataract cases. Colabar glass cuts down both the infra-red and the ultra-violet.

"Papillodema is not pathologic." Check suspected pathology with perimeter.

Arterial pulsation is indicative of abnormal blood pressure.

Beaded appearance of arteries is indicative of hypertension.

Peckham on Cross Eyes

Squint is only an exaggerated phoria.

Phorias and tropias are symptoms.

The two great causes of squint are ametropia and spasm.

Spasm may be caused by intestinal distaurbances, such as colic. Fright causes more convergence squint than anything else. Symptoms are the same in squint caused by colic and fright.

In all spasm squint the eye turns in on the side of the master hand. In all hyperopia squint the eye turns in on the non-dominant side.

Most convergence squint with latent hyperopia commences as alternating squint. (How can this statement be reconciled with the above.)

A third group of squint is a combination of the other two. In these compound cases the squint is usually on the opposite side from the handedness.

In all cases of comitant convergence squint in which squint is on the opposite side of handedness there is latent hyperopia.

Comitant means going with.

Concomitant means going with exactly.

Noncomitant means not going with.

The above definitions refer to the action of the squint eye in versions.

If you can make the bad eye look at you in noncomitant quint the case can be corrected with exercises.

If bad eye follows when good eye is covered and stays still the case can be corrected.

If the squint eye can not be made to turn with the good eye covered it is a case of paralytic squint.

The fusion theory is wrong as taught in text books.

In spasm squint the pupils are very large.

In purely latent hyperopia squint the pupils are small.

In combination case the pupils may be any size.

In all cases of noncomitant squint where squint is on opposite from handedness there is latent hyperopia.

In all cases of comitant convergence squint where squint is on the side of handedness and pupils are large there is no latent hyperopia. These cases are spasm squints.

Do not crowd on plus in spasm squints. Give as little plus as will improve vision. When in doubt choose the weaker lens.

The types of squint differ because of different pathways involved.

In spasm squint there is a block across the pathways over which the accommodative impulse is sent.

There is a block across the road and the orders can not get through in squint. We must tear down the block.

Dynamic skiametry is valuable in studying squint.

Table of normal dynamic skiametry findings for different ages. (I think these findings are found by working up through neutrality):

Age 2 years	5.50
Age 2.5 years	4.75
Age 3 years	4.00
Age 3.5 years	3.50
Age 4 years	3.00
Age 7 years	2.87
Age 10 years	2.75

These dynamic findings do not represent hyperopia but measure the convergence-accommodation function. These amounts should be deducted from the dynamic findings to determine the refractive condition.

Children commence to develop convergence-accommodation when they commence to use words.

In a child of 3 years static skiametry shows 2.00 or 2.25 more plus than the hyperopic error.

The latent hyperopic child is precocious, curious and domineering. He is not content with a blurred image. He focusses and develops his convergence-accommodation sooner than normally. He

reaches the stage of interest in images that is called visual acuity earlier than normally. Twenty-twenty vision comes normally at the age of 10 years. Twenty-fifteen vision comes normally at 14 years. If a child of 6 has twenty-twenty vision he is a latent hyperope. He compensates his structural error. There is **less** plus shown in these latent hyperopes by dynamic skiametry than the above table gives. This is quite different from the dynamic interpretation in older people where **more** plus is shown by dynamic skiametry in latent hyperopia.

Myopia is a sign of trouble in the stomach region.

Myopia as well as latent hyperopia will cause a reduced lag in children.

In cases of cross-eyes if squint is on opposite side from handedness and dynamic skiametry lag is less than normal for the age there is latent hyperopia.

In spasm squint the development of convergence-accommodation ceases. In this case the deduction should be for the age the squint appears.

In case of stammering when dominant eye is on non-dominant side use a ruby filter over dominant eye to change dominancy.

Amblyopia ex anopsia regardless of amount and duration can always be cured. Nerve tissue can be regenerated.

Quickest way to start vision in amblyopic eye is to place ruby glass over good eye for a few days.

Always use prisms with the ruby glass.

Ruby glass is better than occlusion to cure amblyopia.

Vision is the answer to curiosity. Artoscope is a good curiosity arouser. Red and blue are the best colors to use with the artoscope. Having patient hunt for red and blue in magazine adds with a strong magnifier is good amblyopia exercise. Awaken curiosity and you will get vision.

Exercises are to break up existing patterns and leave patient in a dilemma where he must adjust himself to a new condition.

When the lag is reduced to normal the eyes are straight. Plus correction usually reduces as exercises are given in spasm squint. This does not become latent hyperopia in these spasm squint cases.

The amount of energy supplied to a muscle is proportional to the interest and discontent.

Put a pair of 2.50's and 10 prism diopters base-in, O. U., on a young latent hyperopic squinter and leave him with a picture book or something to read for a half hour and you may be able to put more plus on than before.

Attack the squint problem at the near point.

Put a pair of base-in prisms in a fitover to exercise with.

Out of 900 cases of latent hyperopia and convergence squint most of them were found to be underweight and had poor appetites.

When a child comes in for an examination accompanied by an elder always speak to the child first.

Bifocals and base-in prisms will make the latent hyperope put on weight.

Doing the unusual makes for success.

Myopia with convergence squint is a variable of spasm squint.

In treating squint it is very important to have images the same size. Check the relative size of images at near point and make the same by changing the lenses.

In divergent squint with myopia the lag in the eye that turns out is greater and the pupil is usually larger.

Base-out prisms reduce the size of the image.

More than half of divergent squint is neuropathic (sick nerves). Migraines re-occur regularly.

Intermittent squinters have high tempers.

Exophores and intermittent and permanent exotropes are susceptible to flattery. They are highly emotional and great arguers.

Diplopia from toxemia is usually caused by intestinal toxemia. The blood picks up the poison and carries it to the eye. Nerve cells have an affinity for toxins.

Nerve tissue can be totally regenerated. Diplopia following toxemia can always be cured.

Diplopia from tooth infections can not be cured until the infection it removed.

Elderly persons who can not see to read and beg for glasses to read with can be cured with the Arneson method. This is more important than curing squinters from a profit viewpoint.

In squint the problem is to restore the lost muscle control.

Squint must be cured by working on the peripheral vision.

Start with 10 base-in convergence squint when treating with the Arneson-Peckham squint corrector.

Do not use lens correction in spasm cases but do use it in latent hyperopia and presbyopia.

Do not use cylinder correction in using the squint corrector.

Myopia with alternating divergent squint is the only hard case to cure with the squint corrector.

Have an office girl.
Never be in the front room.
See no one without an appointment.

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THE PROFESSIONAL OPTICAL ALLIANCE

A new organization, the Professional Optical Alliance, is sponsoring the National Radio Program which will be broadcasted every Sunday at 5:30 P. M. over a number of the leading broadcasting stations. On these programs there will be featured talks on Style, Eyesight Conservation and also musical numbers. The Professional Optical Alliance is made up of the Shuron Optical Company in co-operation with a number of wholesale houses throughout the country. They are endeavoring, in this campaign, to bring to millions the importance of eyesight conservation as well as the importance of properly fitted glasses.

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BETTER VISION INSTITUTE

Through the efforts of the Better Vision Institute, Mr. Lowell Thomas, well known world traveler, author and radio headliner for the Literary Digest, has been secured to feature a talk on Eyesight Conservation over the National Broadcasting System. Mr. Thomas, having been broadcasting daily for the Literary Digest for a number of months, has attracted millions of listeners. He has a wonderful ability to impart knowledge, and his talk on Eyesight Conservation given the first part of September afforded an opportunity to millions of parents and children to learn of the importance of the proper care of their eyes. The Better Vision Institute is to be congratulated upon the constructive work it is carrying on.

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MINNEAPOLIS OPTOMETRISTS MEET

Dr. Roy S. Peterson addressed the first fall meeting of Minneapolis optometrists, held at the Oak Grove Hotel on Thursday, September 26th. Dr. Peterson spoke of optometric progress on the Pacific coast. A pre-view hearing of the new Shuron broadcasting records was presented to the society along with a number of humorous remarks about those present by Station WDGY, located in the hotel. The Minneapolis Study Class of the Skeffington Graduate Clinic Foundation will meet bi-monthly, starting October 1st.

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MAINE ASSOCIATION MEETS

Dr. A. L. Corriveau announces that the September meeting of the Maine Association of Optometrists was held at the Kenduskeag Country Club at Bangor on Wednesday, September 16th.

A MESSAGE FROM THE A. A. A. O.

Dr. S. H. Robinson, optometrist of Prescott, Arizona, chairman of the American Association for the Advancement of Optometry, submits the following statement to the optometrists of America, in the hope that this will do two things. First, awaken a desire on the part of a large number of optometrists for a more complete optometric practice and also to clarify the position of the society he represents. Chairman Robinson's statement follows:

OPTOMETRY WANDERS

Have you ever observed the pedantic individual? He uses big words to express very simple ideas. So is Optometry today. It has adopted much abstract learning to serve a very small field.

Of course, we find no fault in optometrists striving to make themselves the equal both culturally and professionally of those engaged in other learned professions. What we would point out, however, is the mockery of loading optometrists with indifferent or abstract learning when in the final analysis all they are permitted to do is to refract a pair of eyes. Would it not be better if optometrists were taught work that is not merely academic but wholly practical—work that may afford the opportunity for actual service and economic gain?

Vaguely, our leaders have sensed the fact that the mere prescription of lenses is too limited a field to engage the capacity and satisfy the ambitions of the modern practitioner. To meet this situation, while still believing that optometry is irrevocably bound to traditional limitations in practice, once imposed through necessity, they would pacify our yearning and delude our hopes by introducing in practice related medical tests that demand skill and training, but which directly contribute little to the actual service rendered.

We maintain it is unprofitable and unwise to remain blind to the present situation any longer. We can not grow as a profession on the limited work we are doing, or by resorting to mere ostentation without actually performing a broader service than we are now rendering. We may continue to enlarge upon associated or correlated eye tests, but this is an empty gesture when all optometry can do or is premitted to do, is supply a pair of glasses. It is well to speak of better refraction, but we have already striven and grown so much in that direction. What we now need is some newer channel to engage our effort and expend our energies. And we don't have to wander aimlessly to find a field for our endeavors, neither do we have to create artificial demands for our service. Our daily observations in practice lead us to a practical service—a service that begs of us a bit more than the mere prescription of lenses. The field has long ripened. It is time for Optometry to begin to get ready for that work.

We feel no hesitancy in presenting the thought of professional expansion. We offer no apologies for suggesting that plans will take us out of the morasses in our present wilderness. There is but one problem before us. It is to awaken the conscience of optometrists and optometric leaders to the actual situation; to free them of the delusion of restriction which they have self imposed, and to kindle within them the spirit of wisdom, courage and enthusiasm, qualities indispensable in order to surmount the existing difficulties.

SAMUEL H. ROBINSON,
Chairman, The American Association
for the Advancement of Optometry.

BASHFORD BLDG.,
PRESCOTT, ARIZONA.

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NEW YORK PENNSYLVANIA ACADEMY

The regular monthly meeting of the New York Pennsylvania Academy of Optometry was held at Westfield on September 24th. Dr. Stock presented a paper on "Tentative Method," following which the members discussed a paper on "Suspenopsia" which had been given before this group at a previous meeting by Dr. Morris.

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THE CAUSATION OF MYOPIA

Dr. Thomas Costa, optometrist of Providence, R. I., writes: "An article appeared in the American Journal of Optometry by Dr. Charles Saks of 87 Nassau St., New York City, entitled 'The Causation of Myopia.' The author states that Dr. Peckham has advanced theories, whereby myopia can neither be prevented or checked, and further states that he has not yet seen one case where the myopia was either prevented or reduced, and that if any case has been stopped, it has stopped progressing of its own accord and not by prisms or prismatic treatments. I believe that statements of this nature are somewhat too broad for an optometrist to make.

"Dr. Peckham not only has advanced theories but has proven these theories to be facts beyond any doubt. There are cases of myopia that cannot be reduced or that will not respond to treatments but there are many cases of myopia that *can be stopped* and also reduced.

"I would be delighted to give Dr. Saks complete case reports of cases of myopia which have responded to prismatic treatments under my personal care and incidentally, in all these cases, the myopia did not stop progressing of its own accord.

"There are many diagnostic points which the optometrist must take into consideration in treating cases of myopia. Boys react differently than girls in prismatic treatments, that is, better results can be obtained in boys than girls.

"Myopia may be regarded as a symptom of imbalance in the visceral organs, either in the digestive tracts, in the function of metabolism in the sexual organism, possibly in the endocrine gland. Proper diet has helped many myopic patients, such as alkaline diet in reducing myopia.

"In conclusion, let me state that these facts have been proven and worked out by many optometrists who are meeting with marked results in reducing myopia, and are not fantastic theories."

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OHIO STATE ASSOCIATION OF OPTOMETRISTS

Dr. W. S. Niswonger, director of Publicity for the Ohio State Association of Optometrists, announces that court action against corporations in the state have been brought against Schulte-United Inc. Standard Drug Co., Rudulph Deutsch Co., Betts Optical, Inc., for the illegal practice of optometry.

Counsel J. B. Dworken charges optometrists practicing in these above corporations with illegally practicing the profession. Rapid steps of progress are being made in the state to clean the ranks of optometry of wrongful practice of the profession.

The state law is being rigidly enforced by the Better Vision Society and law enforcement committee of optometry.

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SOUTHWESTERN NEW YORK SOCIETY

Dr. H. J. Meade reports that the first fall meeting of the society was held in Jamestown, N. Y., on Wednesday evening, September 16th. The meeting was preceded by a dinner at the Hotel Jamestown.

The newly elected president, Dr. J. C. Powers of Westfield, was in the chair. The speaker of the evening was Dr. Jarvis, president of the State Society.

Among other business, it was voted to subscribe, in the name of the society, to the "Blue Book." This book is to be kept in the hands of the secretary for the use of the society or any of its members. This is in addition to individual subscriptions by the members.

The next meeting will be held in Olean on October 21st.

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Don't Forget The

WE don't say buy from Bausch & Lomb. We do urge that wherever you buy you select merchandise worthy of your name, worthy of profession of which you are a part.